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ABSTRACT

Science communication techniques are expected to change markedly in the next decade because of the developments on an international scale of coupled information systems in various scientific disciplines and technological missions. A change in techniques is also expected because of growing needs of users as well as of producers of science information. These changes will have profound effects on the principal formal mechanism of communication in the discipline of physics in the U.S.--the archival, primary research journal. The examination of possible changes in the role of U.S. journals reflects the financial and scientific experiences of the American Institute of Physics that publishes 87% of the primary research literature of U.S. physics literature and 35% of the world's physics literature. With financial support from the U.S. National Science Foundation, the Institute is undertaking the development of a National Information System for Physics that should provide scientists with more timely and facile access to the large well-organized central store of worldwide physics information. This access will be made possible by a variety of services and publications each responsive to the changing needs and interests of the many subdisciplines in the physics community. (Author/NH)

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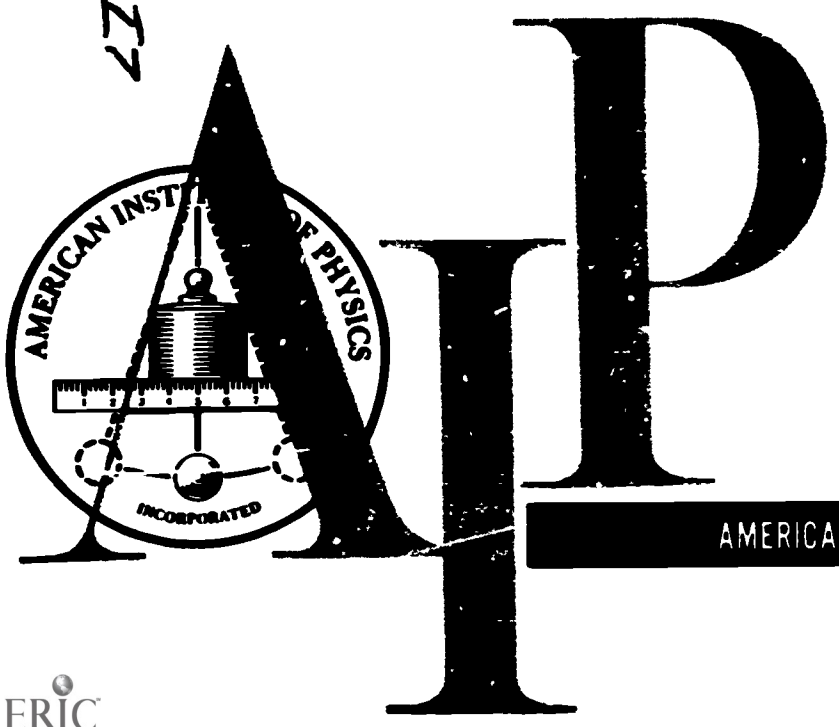
THE ROLE OF THE PRIMARY JOURNAL IN PHYSICS

H. William Koch



Information Division

AMERICAN INSTITUTE OF PHYSICS • 335 East 45 Street New York N Y 10017

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THE ROLE OF THE PRIMARY JOURNAL IN PHYSICS*

H. William Koch
American Institute of Physics
335 E. 45 Street
New York, New York 10017

Abstract

Science communication techniques in the next decade are expected to change markedly from the past because of the developments on an international scale of coupled information systems in various scientific disciplines and technological missions. A change in techniques is also expected because of growing needs of users as well as of producers of science information. These changes will have profound effects on the principal formal mechanism of communication in the discipline of physics** in the U. S.--the archival, primary research journal. The result of these effects should be a strengthened role for the individual refereed articles of journals and an important, but augmented, role for journals as we know them today.

The examination in this report of possible changes in the role of U. S. journals reflects the financial and scientific experiences of the American Institute of Physics that presently publishes 87% of the primary research literature of U. S. physics and 35% of the world's physics literature. With financial support from the U. S. National Science Foundation, the Institute is undertaking the development of a National Information System for Physics that should provide scientists with more timely and facile access to a large well-organized central store of worldwide physics information. This access will be made possible by a variety of services and publications each responsive to the changing needs and interests of the many subdisciplines in the physics community.

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*A talk based on this report will be presented at the Symposium on Handling of Nuclear Information, organized by the International Atomic Energy Agency, Vienna, 16-20 February 1970.

**Although the term "physics" is used throughout this paper, astronomy is assumed to be included; in the U. S., The American Astronomical Society is a member society of the American Institute of Physics.

Introduction

Primary journals in the discipline of physics have been a key communication mechanism that also has provided a multi-purposed record. The record contains research articles as in the JOURNAL OF APPLIED PHYSICS, education articles as in THE AMERICAN JOURNAL OF PHYSICS, and survey articles as in PHYSICS TODAY. Primary journals contain original contributions in full text.

Some scientists feel that the primary research journal is becoming outmoded because of the growing problems of size, cost, quality, and time delays. This report will examine the changing roles of the primary journal, the nature of the problems and proposed solutions, and the future role of the primary journal system. For the present purposes, the primary journal will be assumed to include research articles only. The prediction of a future role for the journal is based on projected plans of the American Institute of Physics to supplement the primary journal system in physics with a series of user-oriented journals (or their equivalents) that, at least initially, will be based upon the present archival journal system. These plans are not final at this writing and are dependent on financial support from the National Science Foundation as well as on approval by the AIP Governing Board.

Changing Roles of Primary Journals

Communication of science information from the producer to the user requires a variety of communication mechanisms and channels.[1] Table I itemizes the conventional mechanisms and groups them according to degree of formality (published, quasi-published, and unpublished) and to degree of depth (primary, secondary, and tertiary).[2] All of the mechanisms listed are important in the subdisciplines of physics and are involved in a competitive, but constructive manner.

For example, most research results are first discussed publicly at scientific meetings; then progress to the report or preprint stage; and finally are submitted to a primary journal editor for inclusion in the record of physics. This chain suggests, in principle, a fixed, orderly procedure for all research results, that, in practice, is a dynamic utilization of whatever mechanism, or combination of mechanisms, is most appropriate for the particular subdiscipline and for the particular research reported. Regardless of what combinations are utilized, the end products of significant research have usually been articles in the primary, archival journal. These articles have established the principal role of the primary journal as the record of activity and progress in a science discipline.[3,4]

The record has been verified, and is objective and public; and, thereby, has greatly assisted science to achieve its enormous public acceptance. In the words of John Ziman, the record represented by the primary literature "may well have been the key event in the history of modern science."[5] Publication in the record is regarded by some to be the prime motivating force for research.[6]

However, primary journals have served another role as a current awareness medium of on-going research.[3] This role was particularly

important in the late 1930's when the annual size of THE PHYSICAL REVIEW, for example, was, in terms of total articles per year, about the same as it is now for only one month. In the 1930's a physicist could read and understand most of the articles in the one or two primary journals in his field. In the 1930's a physicist knew to which journal he should submit his research article in order to reach the audience of other physicists doing similar research because they would be submitting to the same periodical.

Not so today. Now the literature, as demonstrated in Figure 1, [7] has so expanded that physicists have difficulty in reading the literature in their fields of interest. In addition, the fields or subdisciplines overlap more and more so that an individual physicist really should monitor several fields and many different primary journals. The physicist-author now finds that he cannot always predict the appropriate journal to which to submit his article so as to reach a given desired audience. The growth in the primary physics literature has resulted principally from the growing number of physicists and not because of the increased productivity (or any decrease in the quality of the literature). The growth problem is aggravated by the producer orientation of the present journal system, in that the author largely decides when, where, and in what manner the information is to be presented. The user is left to cope with the flood as best he can; as a result, information often comes to his attention too late to adequately satisfy his need.

A dramatic, visual demonstration of the growth in the physics literature is given in Figure 2, which shows four stacks of journals published by the American Institute of Physics in calendar year 1968. These stacks are (1) The AIP Russian Translation Journals--1968; (2) THE PHYSICAL REVIEW--1968; (3) and (4) The Other Society and AIP Journals--1968 (in two stacks). Also shown in the center of the photograph are (5) all twelve issues of THE PHYSICAL REVIEW for 1940, and (6) the five issues of this journal in January 1969 (each stack is five inches thick. If one projects the implications of the January 1969 issue of this one journal to the total year's production of the journal in 1969, then one obtains, for the total 1969 AIP production of journals four stacks of journals, each five feet in height, or a total of twenty feet of published research. A further projection of the world's production of physics research literature can be made from the fact that AIP publishes about 1/3 of this. Thus the total stack height of primary research journals in physics for the world in 1969 is expected to be roughly sixty feet tall!

The conclusion one must draw from an examination of the growth problem is that the role of the primary journal as a current awareness tool for the user is weakening. Many contend that the primary journal can be improved by straightforward application of new production methods such as computerized typesetting, automatic indexing, and computerized referee files. It is the contention of the present author that a more complete modernization and redesign of the entire primary journal system is required.

The practical concern of key leaders in the U. S. federal agencies about the value of the present primary journal system is increasingly evident. The concern can be illustrated by the experiences of the U. S. Atomic Energy Commission, a federal agency with heavy committments in the discipline of physics.

The U. S. AEC partially supports all of the primary communication mechanisms of Table I for its laboratory employees and those of its contractors. Meetings sponsored by AEC laboratories are supported in order to stimulate and improve the informal communication of ideas and research experiences. Reports and preprints are produced and circulated at the expense of the AEC. For example, preprints in high-energy physics, based on a count of the preprint registry entitled "Preprints in Particles and Fields,"[8] are being generated and circulated at the rate of approximately 70 per week.

Similarly, the AEC contributes over $400,000 annually to the primary journals published by the American Institute of Physics in order to cover the pre-publication costs (composition, editing, and refereeing costs) of producing the journals. The pre-publication cost contributions are defined by the page charge plan in which author's institutions are expected to pay about $60 per page toward the support of publishing their author's articles.[9]

Investments of at least $400,000 in each of the three areas of published, quasi-published, and unpublished research are made by the U. S. AEC each year. It is important that AEC management question the value of these investments because of the growing problems with the expanding literature. As will be argued below, however, these investments by the U. S. AEC are essential for the maintenance of a relevant, high-quality, permanent, public record in the subdiscipline of nuclear physics as well as for the improvement of science communication generally.

One reason for supporting society published primary journals containing nuclear physics is, for example, that the scientific and technical standards for this subdiscipline of physics should be maintained by the experts in the subdiscipline, regardless of the end application or relationship of the research to specific federal missions. The public record as maintained by the experts in the subdiscipline is provided by the primary journals of society publishers.

A second reason for supporting the primary journals along with reports, preprints, and meetings is the varying levels of sophistication of the audiences within and outside of the AEC establishments that are interested in, and dependent upon, the results of nuclear physics research. Dr. E. Hutchisson, a former director of AIP, privately brought this point home to this author by observing that the primary journal, the principal element of the published literature, is particularly important to the younger scientists and engineers who require easy and reliable access to the public, formalized literature. They do not have the access which the mature research scientist has to the less formal literature and to informal contacts among colleagues, such as at meetings which large groups of the younger scientists and engineers do not attend.

Therefore, the maintenance of a broad-based, informed, public service activity is accomplished by actively supporting published, quasi-published, and unpublished communication channels. We hope all three will continue to be encouraged and supported because any limitations on the dissemination of scientific findings would have direct negative repercussions on the progress of science throughout the world.

Support of Primary Journals by Payment of Page Charges

Two recent reports[10,11] examine and explain the economics of journal production and recent experiences with the page charge plan. In the first report, Dr. Conyers Herring discussed an exhaustive survey of the "Economics of Primary Publication" in many of the sciences and engineering as published by private, non-profit publishers as well as by private, for-profit publishers. His most important conclusion is that page charges should be continued by non-profit publishers and should be supported by U. S. federal agencies because the resulting reduction in subscription price results in increased circulation of research results and therefore increased "value" to society. A graphic demonstration of his conclusion for physics journals is shown in Figure 3.

The second report entitled "Economics of Primary Journals in Physics" details the financial aspects of the page charge plan for AIP journals. The report describes the success of the plan up to and including calendar year 1968. The cuts in research funds made by the U. S. federal government during the last quarter of 1968 and early part of 1969 had a marked effect in reducing page charge honoring and threatened the earlier success. However, as the report describes, a change in procedure that has resulted in a request for certification of honoring of the page charge contribution immediately after acceptance by the editor of the manuscript for publication, and a temporary change in policy that imposed a publication delay of three months for those "unhonored" pages, has resulted in a sharp rise in the page charge contributions. Authors' institutions are again paying the page charges for their authors. AIP should soon be able to remove the imposed delay and eliminate any discrimination in the processing of articles depending upon whether the page charges are honored or unhonored. The page charge plan continues to be a success for physics journals because physicists, astronomers, and their institutions in the U. S. again recognize their responsibilities to support the plan.

Basic to the success of the page charge plan is the careful separation of pre-run costs from run-off costs of producing a journal. The pre-run costs are chargeable, according to the plan,[11] to the author's institutions as part of the cost of doing research; the run-off costs are covered by income from subscribers. Therefore, the complete burden of production costs for a journal with page charges is not imposed on the subscriber, but is shared between the research worker and the subscriber--shared between the two groups who most directly benefit from the publication. The practical result is the increased circulations over comparable commercial journals that Herring's report documents, and, thereby, the increased "value"[10] to society. Another implication for AIP and its societies is the ability to accommodate to varying levels of research activity in subdisciplines of physics, to increasing production costs, and to varying subscription sizes. The increased financial stability provided by this ability allows us to focus on high scientific standards and not on making a profit.

Opponents of the payment of page charges frequently suggest that all primary journals should be operated according to commercial journal standards and without page charges. Let us examine the implications of such a procedure for society publishers and the role of commercial publishers.

Society publishers, just as commercial publishers, must recover the

complete cost of journal production. The cost of production for an operation as large as that produced by the AIP in one year--65,000 text pages in 1968--is substantial, about $5 million dollars per year. For this many text pages (doubling every 7.5 years) the total cost (pre-run plus run-off) would be intolerable when paid by subscribers alone. At present, subscribers pay about 0.7¢ per page for AIP journals,[11] so that the total annual AIP production can be purchased for about $450. As Herring has noted, comparable commercial journals must charge about ten times as much.

A decreasing number of institutions would be able to afford the increased prices if AIP were to operate without page charges. There would be decreased subscribers while production costs and number of input research articles continued to increase. Fewer and fewer subscribers would be bearing higher and higher costs. The result would indeed be an unstable, exploding condition and would force AIP to operate competitively with commercial publishers. What are the implications of such an operation?

Commercial publishers must also obtain sufficient income from a combination of sources to cover the publishing costs and they must operate with a profit. Most commercial publishers rely on advertising income to allow them to reduce subscription prices sufficiently so as to increase circulation to a level attractive to advertisers. However, many subdisciplines of physics, such as mathematical physics and physics of fluids, are unattractive to advertisers. Therefore, those commercial publishers who rely on advertising simply avoid many physics subdisciplines regardless of their scientific merit. The motivation of AIP would have to be the same as that of a commercial publisher if AIP were to remain competitive with commercial journals. After all, AIP, as a strictly commercial operation without page charges, could not long remain in business if all of the profitable journals were operated by commercial publishers and all of the non-profitable journals were operated by AIP.

Some commercial publishers have done a remarkably good service of publishing primary journals in selected interdisciplinary and international areas even without advertising income. These publishers are dependent on the indirect subsidy of "guaranteed" library subscriptions. However, their ability to do so effectively is dependent on the relatively small number of such journals and publishers compared to the larger body of publishers being associated directly with scientific societies and operating in the direct interests of the scientific community.

Encouragement of an Improved Role for Primary Journals

Some proposals for discontinuing the financial support and, even, the use of primary archival journals are based on the diminished utility of the journal as a current awareness tool. Advocates of diminishing support ignore the other important functions of the journal and the various proposals for improving its communications effectiveness. The improvements are dependent on the efficient and continued production of the primary journals and are under study at the present time by the American Institute of Physics with financial support from the National Science Foundation. We propose implementing numerous improved communication mechanisms and services, including the development of a series of journals that reprint, on a current basis, selected articles on specific subjects from several (refereed and

edited) primary archival journals so as to be oriented towards user interests more so than are the archival journals themselves. (These new periodicals are here referred to as "user journals.") Each of the new channels of communication is being designed to meet the needs of individual, practicing physicists for pertinent, evaluated information.

Improvement in communication mechanisms will require evolutionary changes, rather than revolutionary changes, in the primary journal. It will require a direct influence of the changing needs of individual scientists for information that has specific characteristics of quality, timeliness, and economy. Trade-offs among these characteristics and others that will occur during the next few years will cause considerable change in the parameters of any projected user journals. Let us illustrate by describing an integrated archival user journal scheme. This description will be facilitated by the diagrams of Figures 4A, 4B, & 4C and by a brief preliminary discussion.

Figures 4A & 4B indicate the growing sizes and complexities of the primary journal system in earlier times. In Figure 4A the characteristics of journals are schematized for 1920-1945 when the number of archival journals was small and these journals did an excellent job of serving both producers and users. In Figure 4B the characteristics are depicted for 1945-1970 when archival journals had grown to such a size and number that users were increasingly tending to personal production of customized separates journals by photocopying pages from the archival journals. In Figure 4C, the separation of the producer role from the user role of the journal is shown for the present period from 1970 on.

In the past, as now, AIP and our member societies published a set of archival journals for our memberships. These journals satisfied members' needs as users as well as producers. The publication of archival journals for our members as authors will continue to be necessary. However, as users our members are increasingly interested in obtaining rapid and economical research results, regardless of what geographical location in the world or what scientific or engineering discipline was the production source of the information. Therefore, AIP plans continued expansion of its journal publishing and marketing program. Currently, we are publishing 21 journals, 13 translation journals, and marketing in the United States 8 journals of The Institute of Physics and the Physical Society (London). We expect to add other foreign journals to the program and eventually include bilateral agreements for the handling of hard-copy, microform, bibliographic material on computer tape, indexing, and, integration into what has been called the National Information System for Physics.[2] It is our hope that we can include in this system most of the world's significant journal literature of interest to our memberships. A reasonable goal would be the marketing of some 70 core journals containing about 80% of the journal literature (and a higher percentage of the important literature).

Returning to our proposed new journal "scheme", we know that the present standard for timeliness of our journal literature--some six months between receipt of a manuscript by the editor and its publication[11]--is not really satisfactory (even though it is considerably faster than that for most other disciplines) and a great deal of effort in improving the efficiency of manuscript flow both in the editor's office and in the publication process is underway which will reduce this time to about four months (or perhaps even less). Even with this reduced time it will be possible to alert readers of

forthcoming articles of interest to them before (or simultaneously with) publication. Such an alerting would be either through a classified current awareness journal of titles or through various Selective Dissemination of Information (SDI) services based on a computer file of these titles and appropriate indexing information. The procedure for classifying the titles (in interest groups) would also be used for "classifying", that is, repackaging the articles themselves, so that along with the publication of the archival journals there would also be published a set of "special interest" or user journals, in which an original archival article might appear several times.

A user who subscribed to one or two of these specialized journals would receive most of the articles to which he had been alerted. For the others, he would have several options: To write to the AIP for an off-print or microfiche of that article; to wait until his library receives the appropriate archival journal; or to order a copy from a special microfilm service which the AIP would supply his library. This service would consist of microfilm reels with all the articles in this "core" group published in the preceeding month. In this way the reader has the immediate browsing capability in the "core" of his interest through the user journals and a broader browsing capability in the remainder of his interest at an earlier time, either in the current awareness journal or in his SDI printout. The archival journal is still there as a formal record and a retrospective tool--all references would be made to it rather than to the reprinted collection. In this way the formal scientific record would remain intact.

During the course of this year, AIP will market the prototypes of these alerting services in a titles journal called Current Physics Titles (or CPT) and in a magnetic tape service called Searchable Physics Information Notices (or SPIN).

An important aspect of the operation of this scheme is in the selection of the input archival journals to represent the significant literature (see Figure 4C). All of the input journals should have comparable standards of content, quality, and timeliness. If the number of input journals is too small, the resulting user journals would have characteristics similar to the input journals and no useful purpose would be served by producing user journals. If the number of input journals were to be too large, then the user journals would tend to include too much material that was irrelevant or of poor quality. Also, if the number of input journals were indiscriminately increased for the sake of coverage, the important function of reviewing and refereeing in AIP and other high-quality journals would be of little use since the articles rejected originally by one of these journals could easily have been published in unrefereed input journals and could thus be included in the user journals.

In conclusion, the same basic requirements for the production of archival journals are also involved in the production of successful user journals of high quality. The requirements are:

(1) A coordinated, cooperative, cohesive, and well-defined community of scientists operating in a science discipline as presently exists in the discipline of physics in the U. S.

(2) Page charge subsidies to the primary journals of society publishers that will encourage and support the community

to develop high scientific standards in the publication of primary research articles.

(3) A user-oriented set of journals provided to a user group of scientists and engineers whose information needs are not being satisfied adequately by existing archival journals.

Acknowledgment

The development of improved communication mechanisms in a science discipline is an evolutionary process in which many scientists must take part. In the case of physics communications, the exciting innovations now being explored are partly the result of contributions from a growing number of enthusiastic participants called information respondents of AIP, and members of an advisory committee presently chaired by Professor Philip Morse. We acknowledge their encouragement and support as well as that of two particular individuals who have prodded and invented to make an improved physics information system a reality. They are: Dr. Samuel A. Goudsmit, who has been the father of many of the innovations in physics information to date; and Dr. Arthur Herschman, who has been and is Director of the AIP Information Division during a most critical period of gestation.

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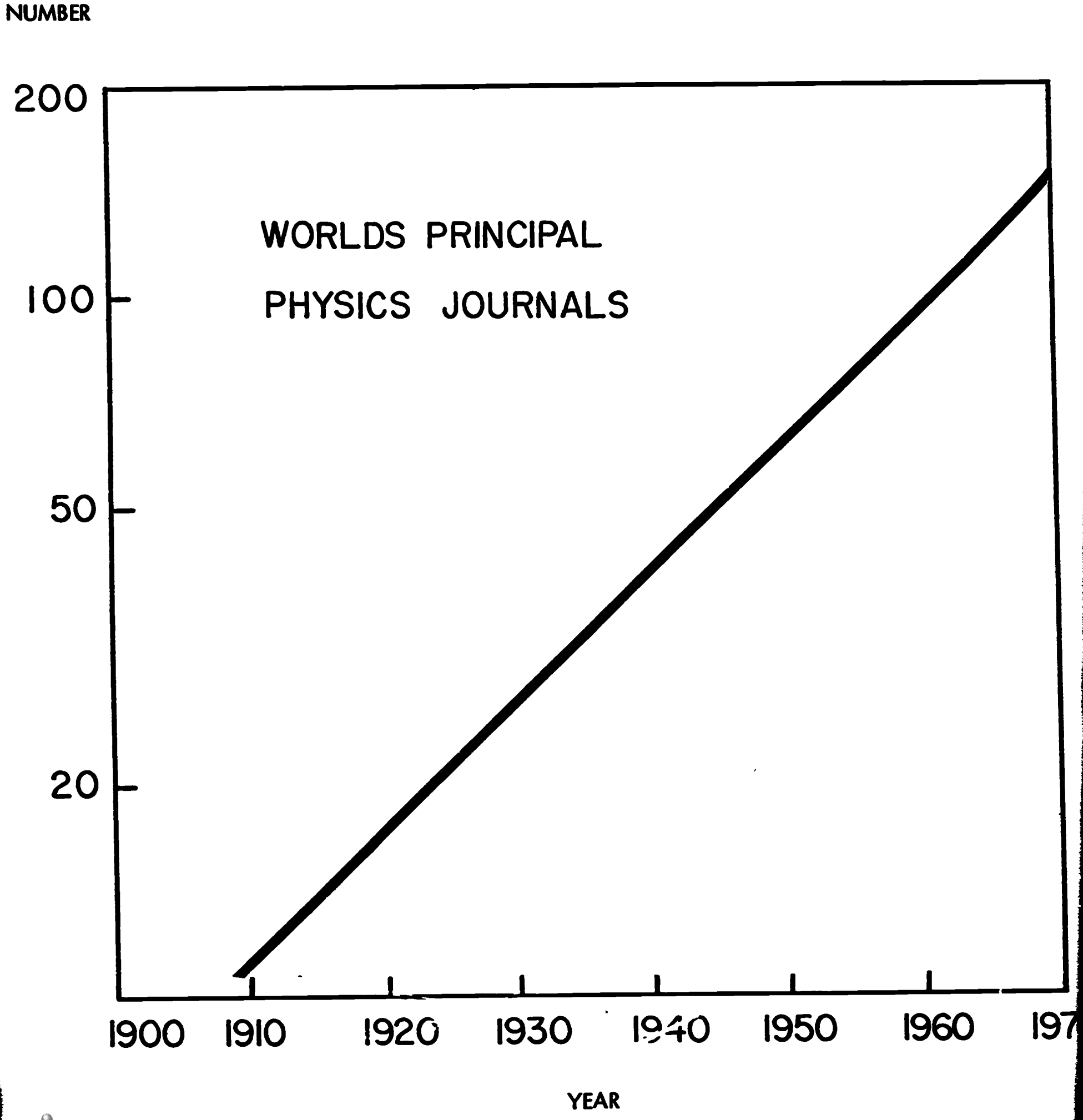
TABLE I

The Kinds of Information in Physics

	Published	Quasi-Published	Unpublished
Primary	Journals Monographs	Reports Preprints Patents	Meetings Seminars Letters Conversations
Secondary	Abstract Journals Current Awareness Journals Bibliographies News Articles	Internal Alerting Services Tape Services	Letters Conversations
Tertiary	Reviews Compilations Monographs & Books	Reports Information & Data Centers	Lectures Conferences Symposia

FIGURE 1


NUMBER
200
100
50
20
WORLDS PRINCIPAL
PHYSICS JOURNALS
1900
1910
1920
1930
1940
1950
1960
YEAR

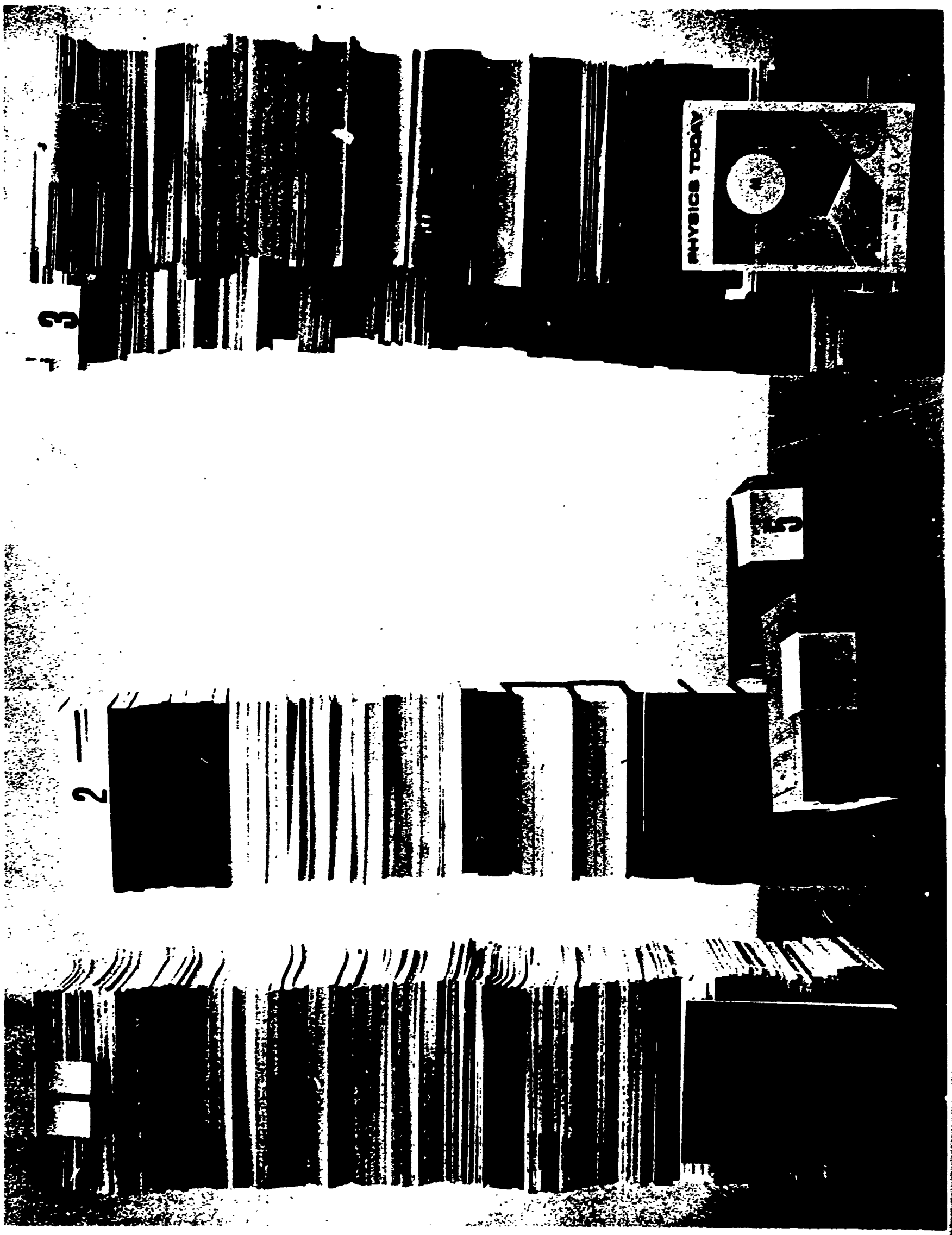
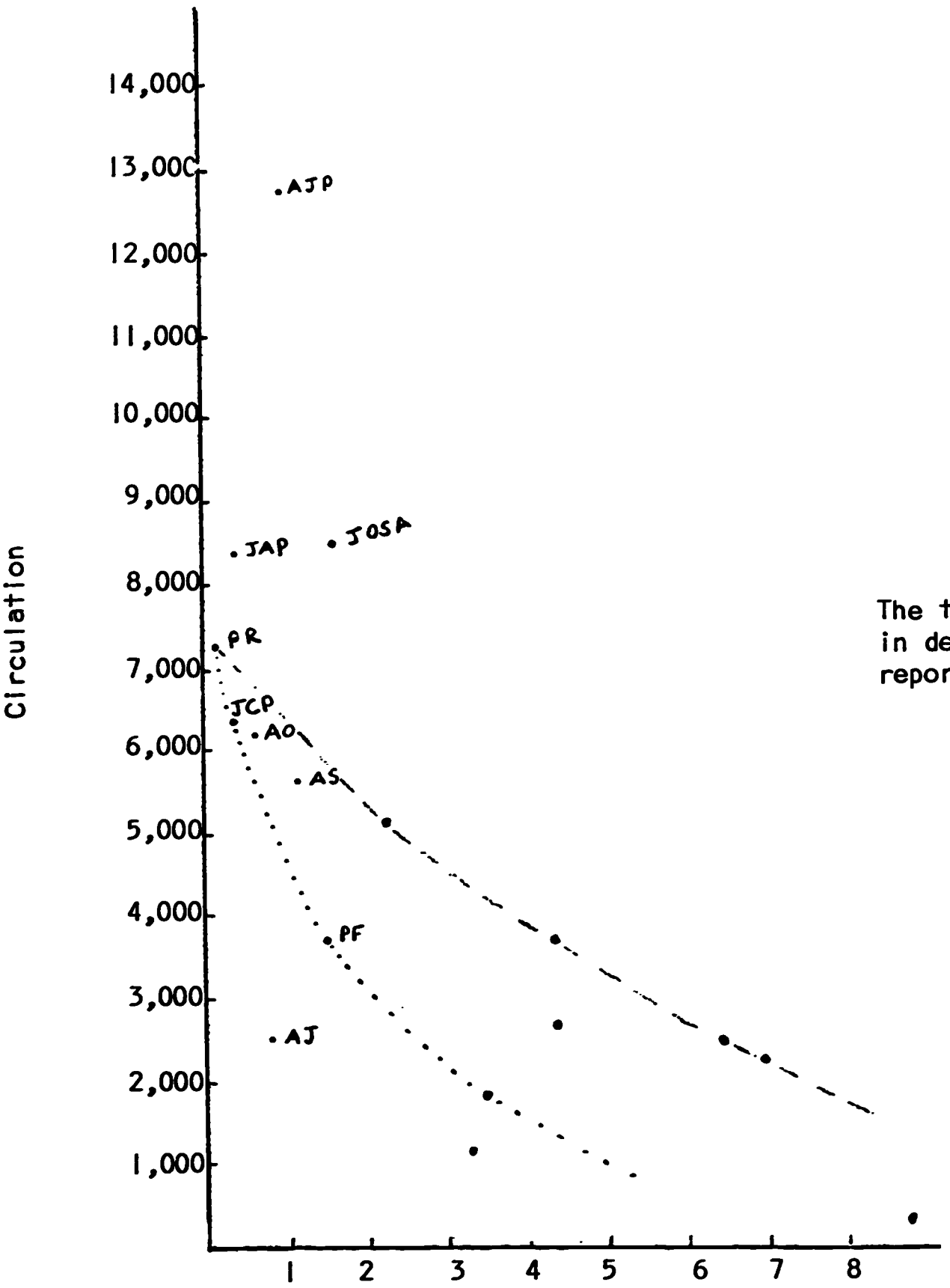


FIGURE 2

FIGURE 3



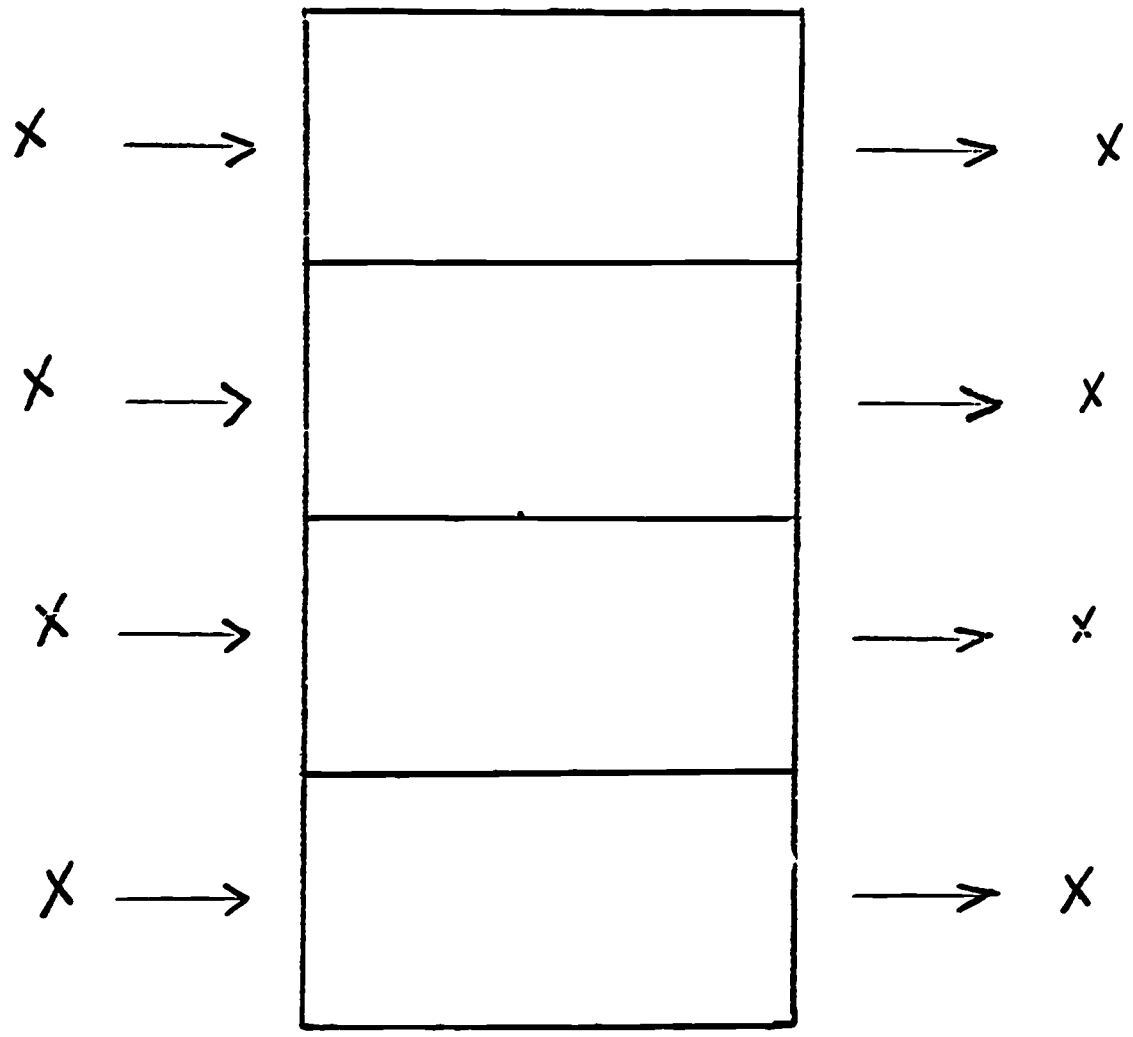
The two curves are explained in detail in Dr. Herring's report. [10]

AJP (American Journal of Physics); AO (Applied Optics); AS (Applied Spectroscopy); AJ (Astronomical Journal); JAP (Journal of Applied Physics); JCP (Journal of Chemical Physics); JOSA (Journal of the Optical Society of America); PR (Physical Review); PF (Physics of Fluids).

Unlabeled dots represent non-AIP journals.

FIGURE 4A

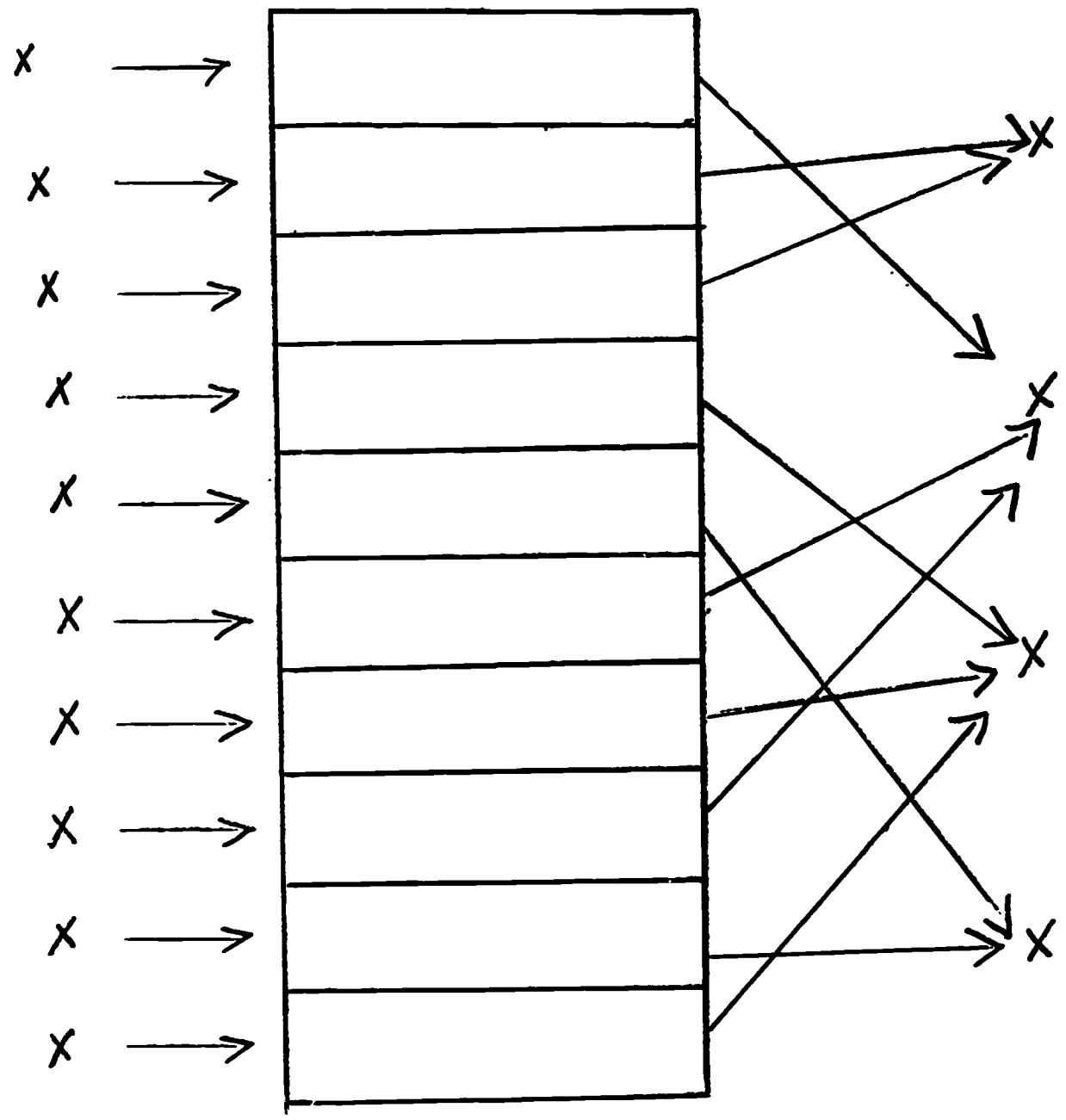
1920-1945



Period when archival journals were few in number and served both producers and users.

FIGURE 4B

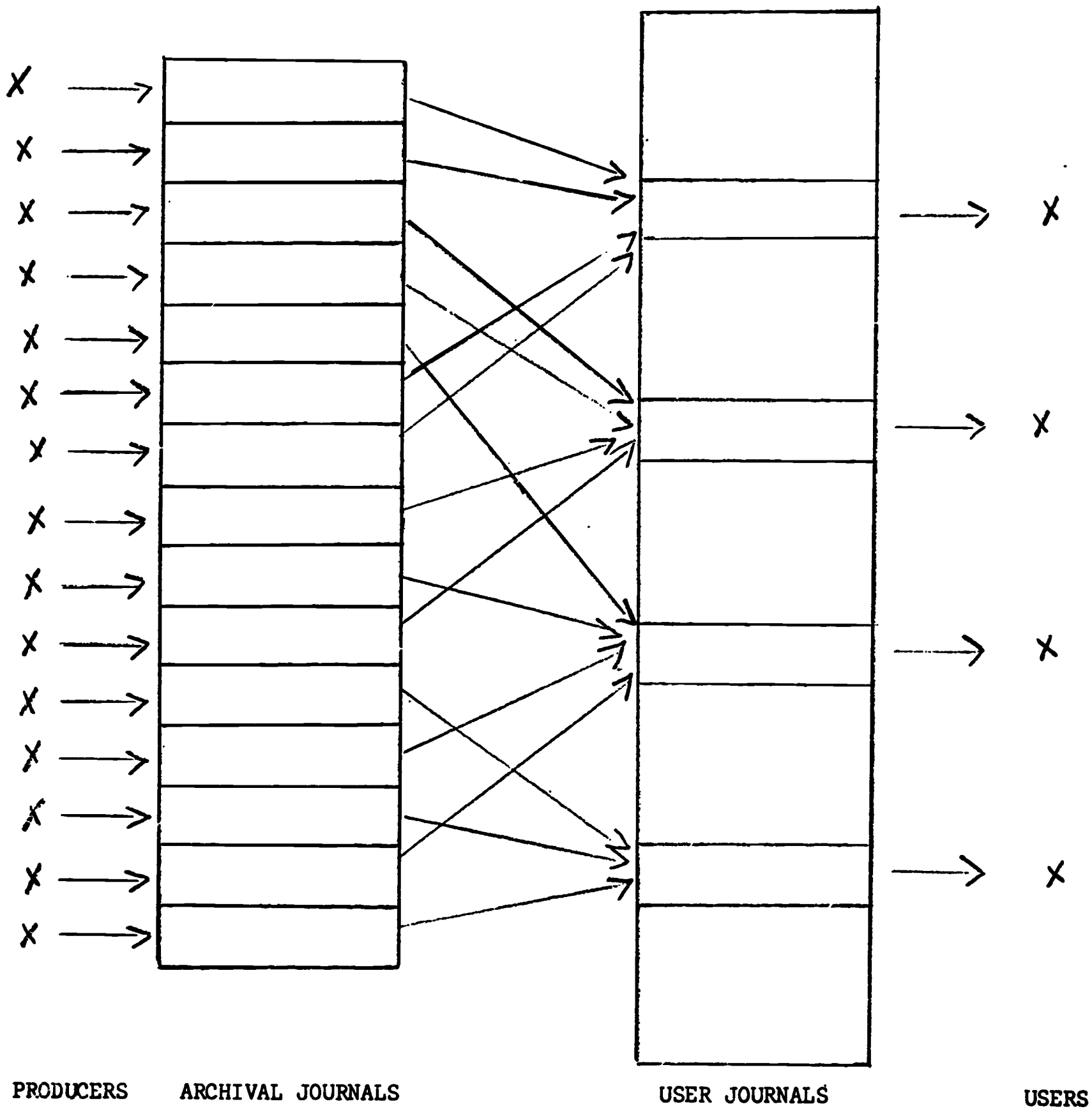
1945-1970



Period when archival journals have grown in number and size so that users have been forced to random copying and to production of their own customized separates journal.

FIGURE 4C

1970-



Period when user-orientation is being separated from producer-orientation and group-customized separates journals are being produced.